



**RESEARCH DEPARTMENT**

# **An optical device for simulating the colour reproduction of a colour camera employing Plumbicon tubes**

**TECHNOLOGICAL REPORT No. T-161**

**UDC 621·397·334:  
621·397·331·222**

**1966/1**

**THE BRITISH BROADCASTING CORPORATION  
ENGINEERING DIVISION**

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COLOUR CAMERA EMPLOYING PLUMBICON TUBES**

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## AN OPTICAL DEVICE FOR SIMULATING THE COLOUR REPRODUCTION OF A COLOUR CAMERA EMPLOYING PLUMBICON TUBES

### SUMMARY

An optical device which can be carried in the pocket simulates the chromaticity and luminance errors caused by lack of far-red sensitivity in a plumbicon colour camera.

### 1. INTRODUCTION

The plumbicon is a photo-conductive camera tube employing lead oxide for the sensitive layer. At present its spectral response, which is illustrated in Fig. 1, is deficient in the longer wavelength region, so much so that equalization with a filter would be impracticable. As a result, errors occur in both luminance and chromaticity. These errors cannot be predicted from a knowledge of only the chromaticity of the object, since they depend on the shape of its spectral reflection characteristic. Thus, objects which appear to have the same colour when viewed by eye may be reproduced differently by a colour camera employing plumbicon tubes (or indeed by any colour camera having incorrect analysis characteristics). There is, however, a general tendency for reds to appear insufficiently saturated or too dark. Magentas tend to appear too blue.

The defect in colour response occasioned by the

lack of far-red sensitivity is important. Nevertheless, the advantages offered by the plumbicon tube in other respects are so great that plumbicon colour cameras are certain to be widely used, both in Europe and the U.S.A.

Since the colour error can occasionally be quite severe, it would be highly advantageous to have a simple optical device which could be carried in the pocket and which would enable the error in the reproduction of coloured objects to be determined without the use of a colour camera and monitor. For example, such a device could be used when selecting materials for costumes and sets, or for use during the preview of a fashion show which is later to be televised. A more immediate advantage is the ability to look at a wide range of scenes in order to determine the importance of the colour error and to see whether the errors are sufficiently consistent to enable some kind of electronic correction to be made.

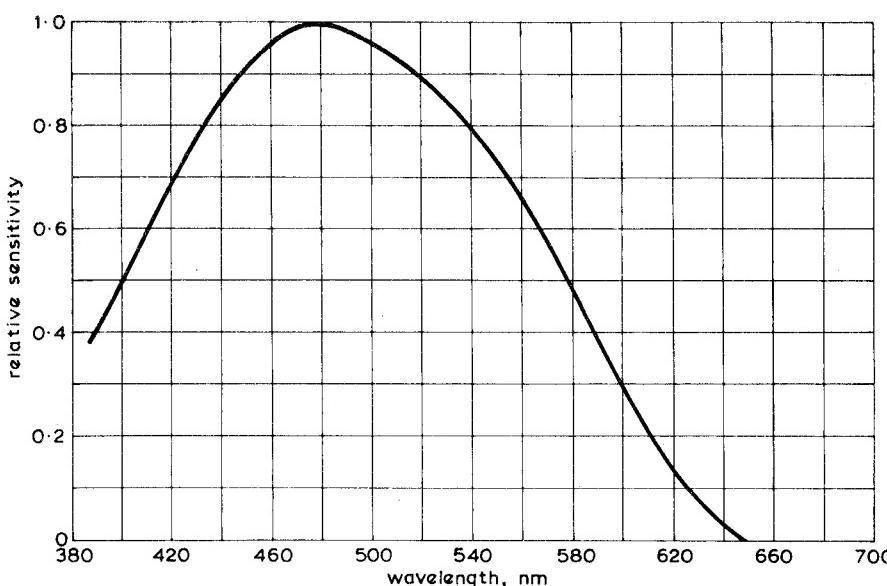


Fig. 1 - Spectral response of the plumbicon tube

## 2. PRINCIPLES

Since the colour error is caused by lack of response to the longer wavelengths, it may be simulated by viewing the scene through a filter which cuts off the longer wavelengths sharply in a manner similar to that of the plumbicon tube. Such a filter must have a pale cyan appearance when viewed by transmitted light, but in a colour television camera the gains are normally adjusted so as to make the reproduction of white and neutral grey colours correct. The effect is equivalent to increasing the response of the camera in those parts of the red region where the tube is operative in order to make up for the lack of response to the longer-wavelength reds. In the optical device a similar result can be achieved by the use of a second filter which is pale pink, and whose transmission varies more slowly with wavelength. This is chosen to make the combination of both filters appear neutral to white light.

Even if a colour is not altered when viewed through the composite filter the reduction in luminance may give the subjective effect of a colour change. For this reason, it is desirable to use, in addition to the composite filter already described, a truly neutral filter and to observe the object under consideration through the composite filter and the neutral filter in turn, noting any change in colour and/or luminance which occurs.

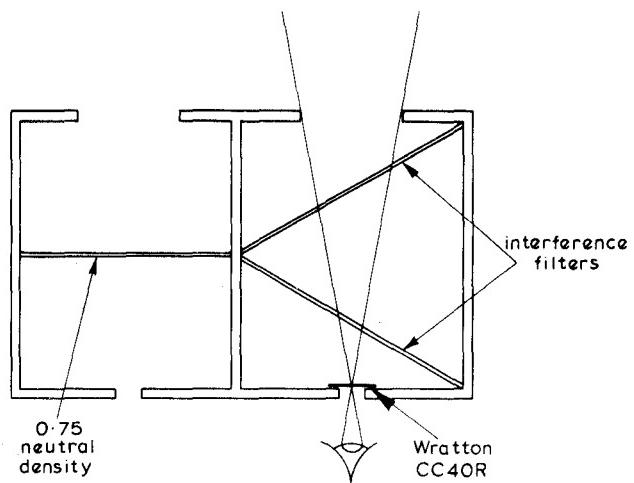


Fig. 2 - First model of the device

The simulation of the colour errors by the optical device would be exact only if the colour analysis characteristics of the camera were equivalent to the ideal characteristics (including negative lobes in the analysis curves) apart from lack of red sensitivity. In fact, the analysis curves do not take this form in practice; indeed, it is by no means certain that such curves would be the best to use. It is, however, thought that any error in simulation must be similar in order of magnitude to the colour errors

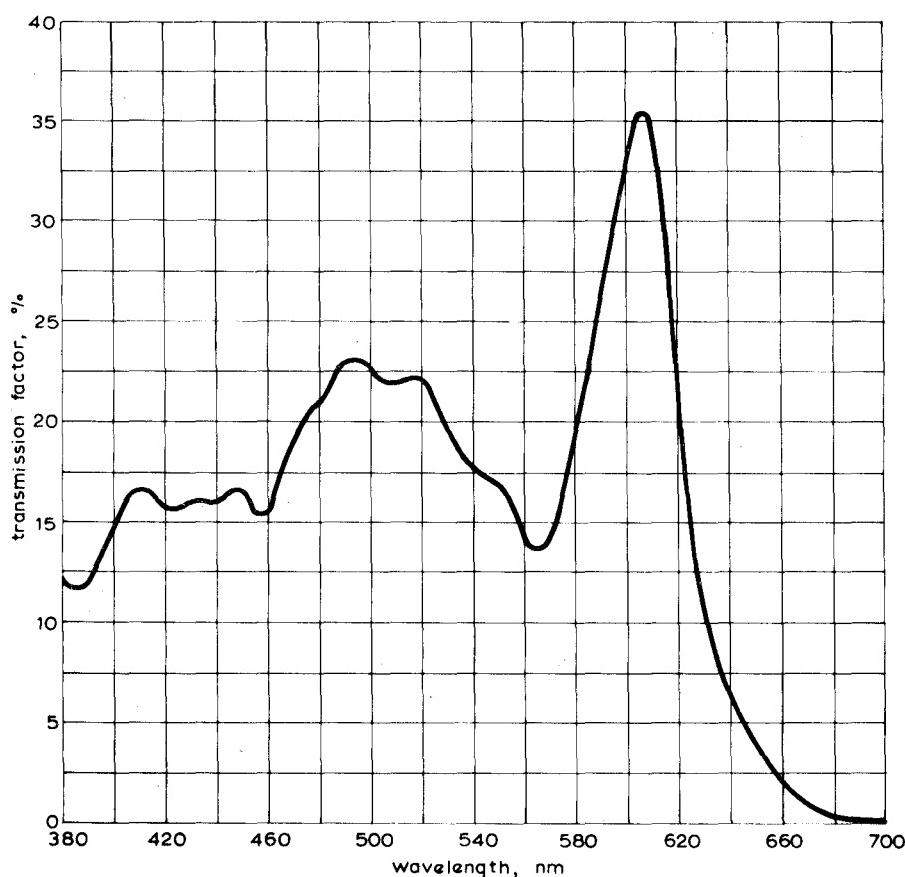


Fig. 3 - Spectral response of the composite filter

caused by the use of analysis curves lacking negative lobes; these errors are quite small.

### 3. EXPERIMENTAL

The first device\* was made up as illustrated in Fig. 2. At that time the only filters available were dielectric filters which began to cut off at too long a wavelength. Two of these were therefore used, and were tilted at an angle to the line of sight in order to move the cut-off to about 620 nm. A gelatine filter (type Wratten CC40R) was added to restore neutrality when viewing white objects. Because the tilted filters were very sensitive to small changes in their inclination - even though they were tilted in opposite directions - it was necessary to restrict the range of angles as shown in the Figure. The spectral response of the composite filter is shown in Fig. 3. It must be emphasized that Figs. 1 and 3 are not directly comparable, because the former takes no account of the use of unequal gains on the three channels of a colour camera. The red channel of a colour camera using plumbicon tubes with the spectral sensitivity curve shown in Fig. 1 would have a response equal to about 50% of the maximum at 620 nm; the transmission curve of Fig. 3 has been arranged for a similar result.

The other half of the device contained a neutral filter of density 0.75 to give a similar transmission of white light.

The device illustrated in Fig. 2 was compared with a plumbicon colour camera in the colour studio in Philips Research Laboratories, Eindhoven. The scene which had been set up included many different colours, and had been particularly arranged to include a number of colours which were badly reproduced by the colour camera, such as deep reds which were reproduced almost as black and a highly unusual pink which appeared almost blue. In all cases the optical simulator was observed to simulate the response of the camera quite well.

### 4. CONCLUSIONS

In view of the satisfactory performance of the experimental device, which may be termed a "plumbicon colour simulator" a more compact version is being made in the form of a flat plate, using an interference filter having the desired wavelength cut-off. It is believed that devices of this kind will be very useful in connection with make-up, wardrobe and scenery. The experimental simulator has already been used to gain experience of the colour errors produced by lack of far-red sensitivity over a wide range of scenes. This experience has enabled the general trend of the errors to be appreciated so that an electronic device for producing some degree of correction could be devised.

\* Developed by Mr. M.K.E. Smith

